

Smoke Transport from Canadian Wildfires to the Mid-Atlantic in 2014

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Summer of Smoke 2014



PyroCb from Saskatchewan July 7, 2015 CIMSS satellite blog.

Introduction

Severe wildfires appear to be on the rise in northern latitudes. Possible causes include increases in temperature, dryness, and winds. The effects are wide ranging from climate to human health. Wildfires release stored carbon into the atmosphere, smoke travels, and soot deposited in arctic regions can change the albedo of ice thus reducing reflected light. Also, smoke affects air quality and produces haze. When smoke comes down to ground level it cause respiratory problems. Particles smaller than 2.5 microns, known as PM 2.5, within the smoke are especially hard on the lungs.(EPA, 2014) (Volland, 2010)

Pyrocumulonimbus firestorms (PyroCb): In a normal cumulus or cumulonimbus cloud, convection results from sun warmed earth. In pyrocumulus and pyroCbs, intense heat from severe wildfires provides the convection. The pyroCb is more extreme than pyrocumulus. It is an explosive fire-caused thunderstorm cloud that causes fire to spread very rapidly. The chimney effect takes smoke high into the troposphere or even the lower stratosphere. Smoke at these higher altitudes can be transported more quickly and over longer distances. PyroCbs were first recognized for their effect on the upper atmosphere about 15 years ago when particulates in the stratosphere were found that could not be traced to volcanic eruptions. (M. Fromm et al., 2010)

Project Objectives

- Study smoke transport from Canada to the Mid-Atlantic region to find time of travel, trajectory, and altitude using HMS smoke maps, CALIPSO, and HYSPLIT.
- Look for correlation with pyroconvection events and look at the effect on air quality using AOT (Aerosol Optical Thickness) data from Aeronet and PM 2.5 data from AirNow-Tech taken from sites in Maryland.

Results

The 2014 AOT data (bottom middle graph) shows peaks corresponding to the smoke events in Maryland occurring from 7/20 to 7/23, 7/29 to 7/31, and 8/7 to 8/10. These peaks are missing from the PM 2.5 data (top middle graph). Since the PM 2.5 data are sampled at ground level and the AOT results are from a column of air, this indicates that the smoke was not at ground level.

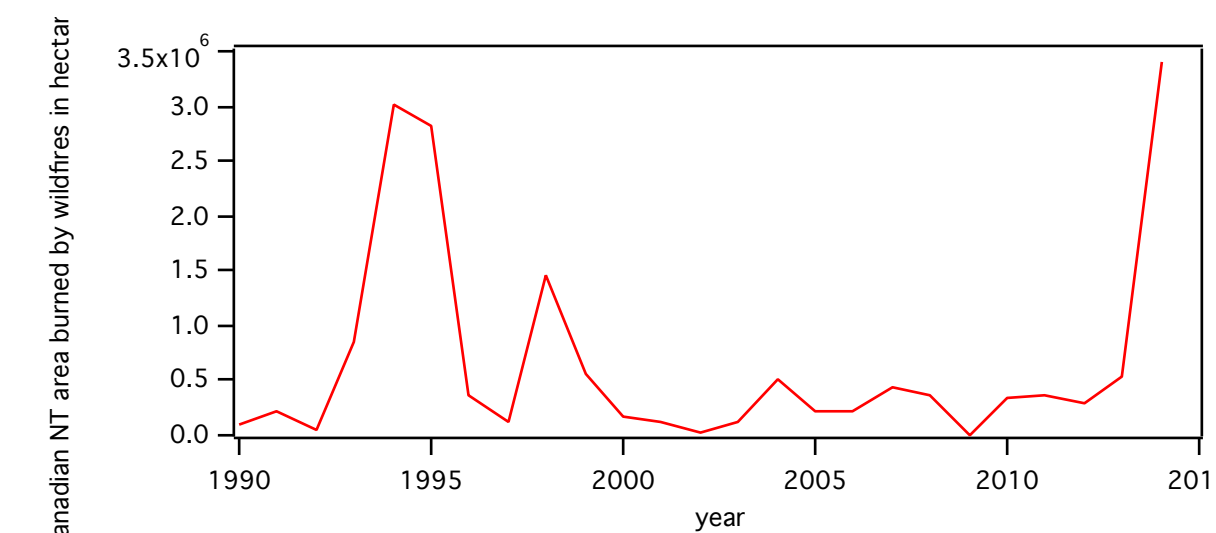
Looking at the CALIPSO data for 8/7/14 in the middle of the page for 39N, 78W the smoke (black bar in the bottom CALIPSO image) is located from 4 to 6 km in altitude. Entering this data into HYSPLIT back trajectory shows the origin of the smoke to be in western Canada.

Alternatively, using the location of a known pyroCb from 8/5/14 and doing a forward trajectory shows the smoke going to the east coast indicating a link between the 8/5 pyroCb and the smoke on the east coast 2 days later. The table on the right shows where smoke in Maryland (pink dates) are recorded with known pyroCb's recorded in yellow for Canadian locations and in green for sites in the United States. On several dates a pyroCb in Canada is followed two or three days later by smoke over Maryland suggesting that there may be a correlation.

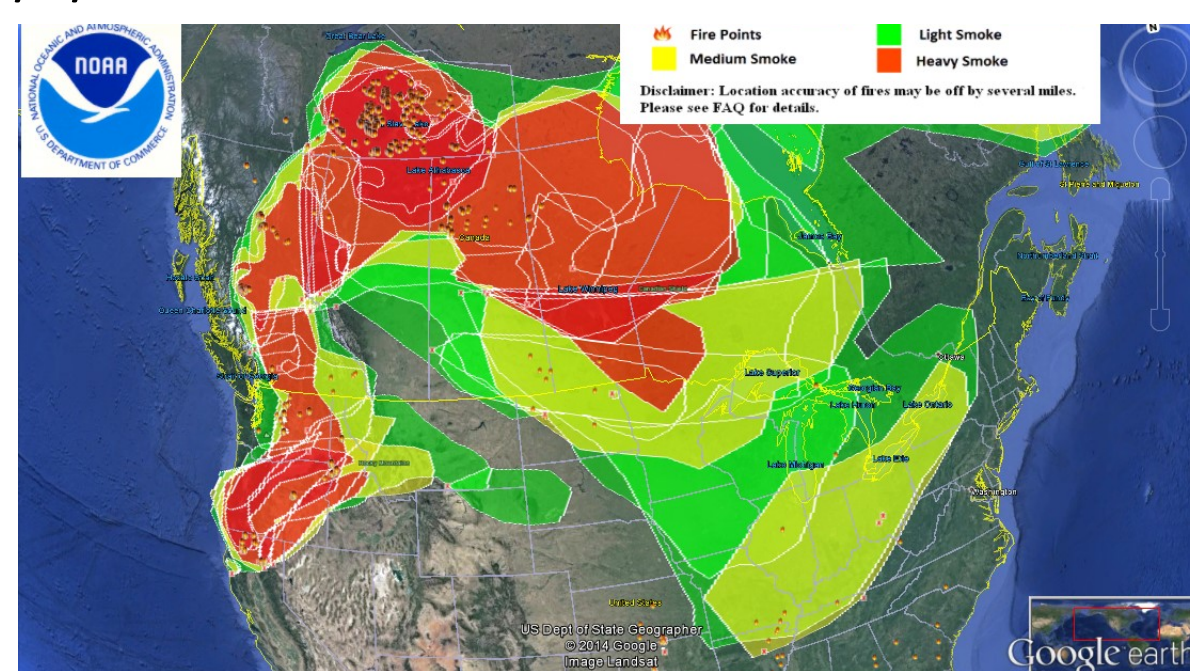
Interestingly, during this summer (2015), there was a smoke event beginning on 6/9/15 in which the smoke did touch ground on 6/11/15 in Maryland. Comparing the PM 2.5 data with the AOT data shows a peak on that date for both graphs.

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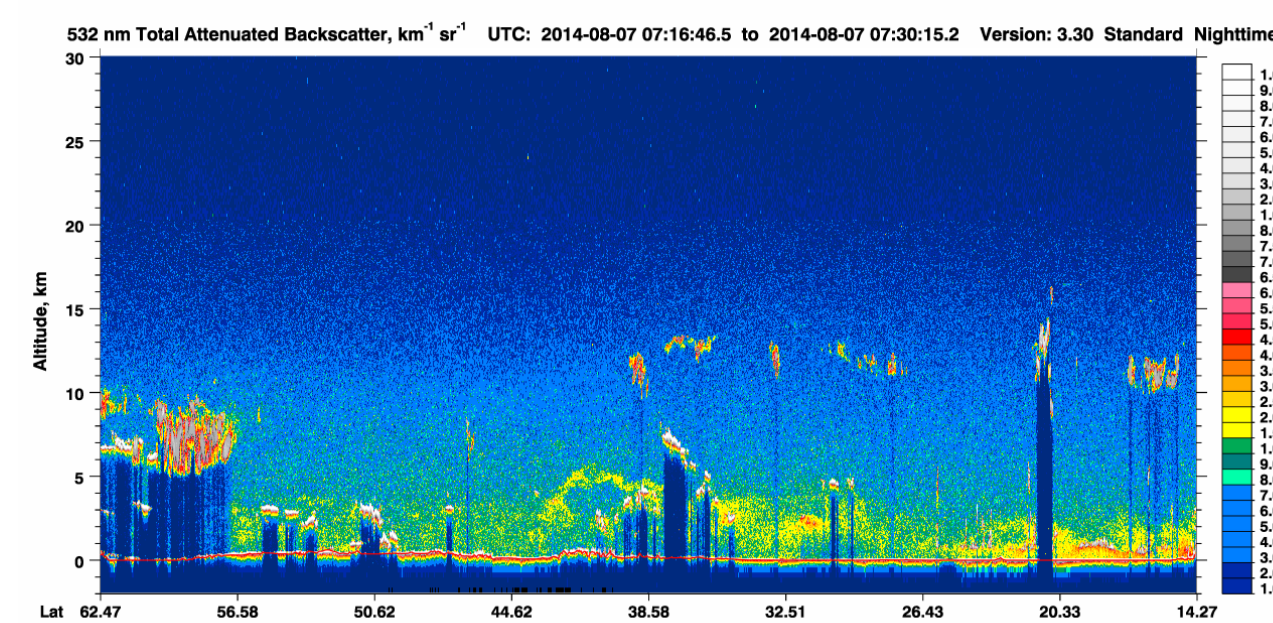
2014 was a peak year for Canadian wildfires. In the Northwest Territories alone, 3.4 million hectares were burned (figure to the right). On many days much of North America was covered by large swaths of smoke from wildfires.



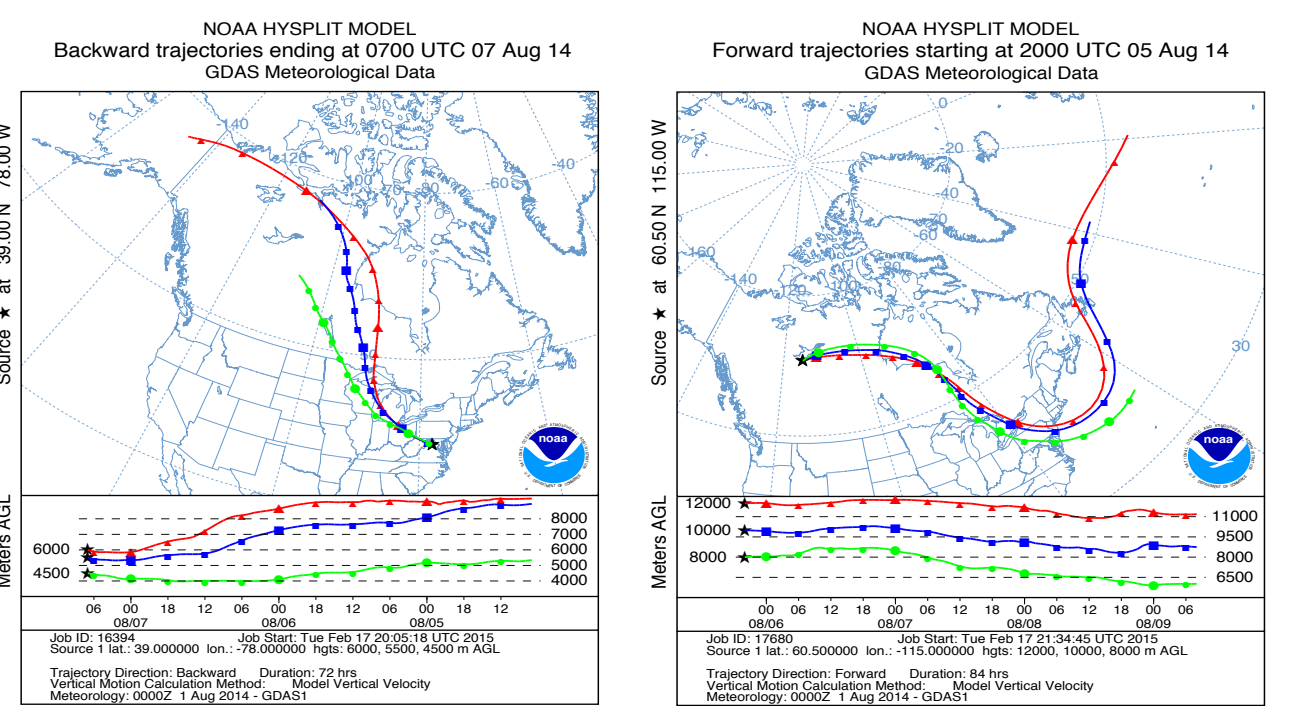
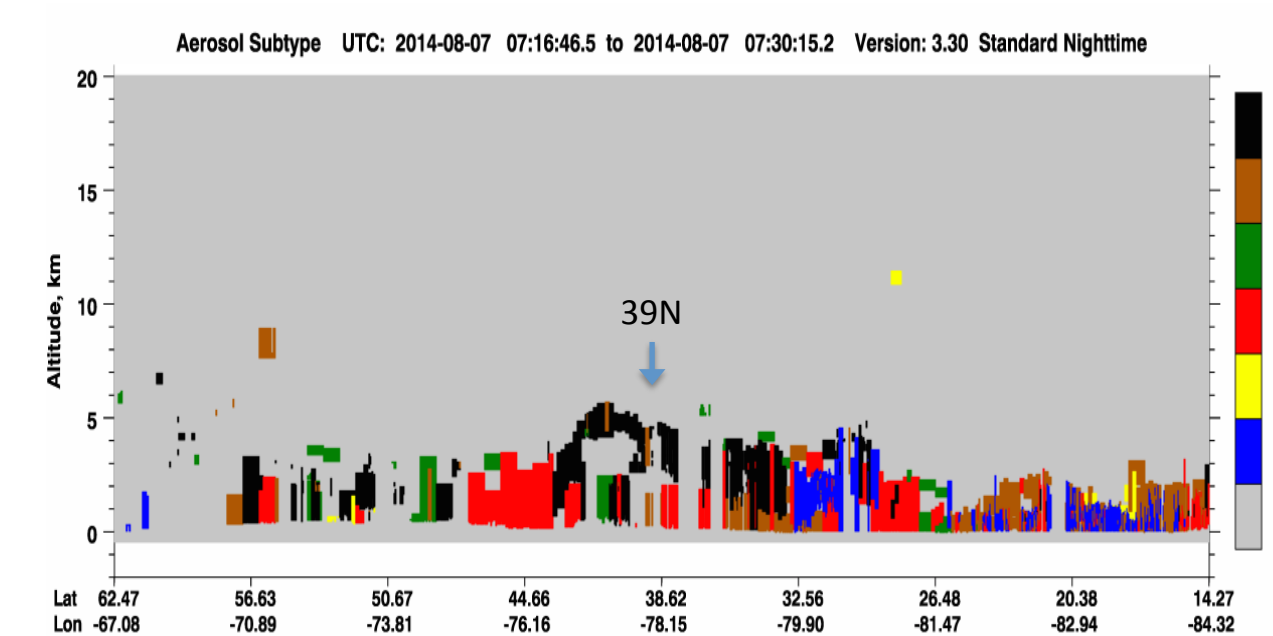
The NOAA HMS smoke map of North America, below left, is from 8/04/14. Notice that there is smoke near to but not on the east coast. The red area shows regions of heavy smoke, yellow is medium and green is light. Wildfires are shown with points. Notice all the points in the middle of the red area which is the Great Slave lake region of Northwest Territories (NT) Canada. This is the site of a pyroCb from 8/5/15 in the right figure which is a true color MODIS image. Also notice the US pacific northwest shows considerable wildfire activity. On the pyroCb there is the characteristic white cauliflower top which is very high in the atmosphere. Notice how it shadows the grey smoke below. This pyroCb occurred 2 days before the smoke showed up over Maryland on 8/7/15.



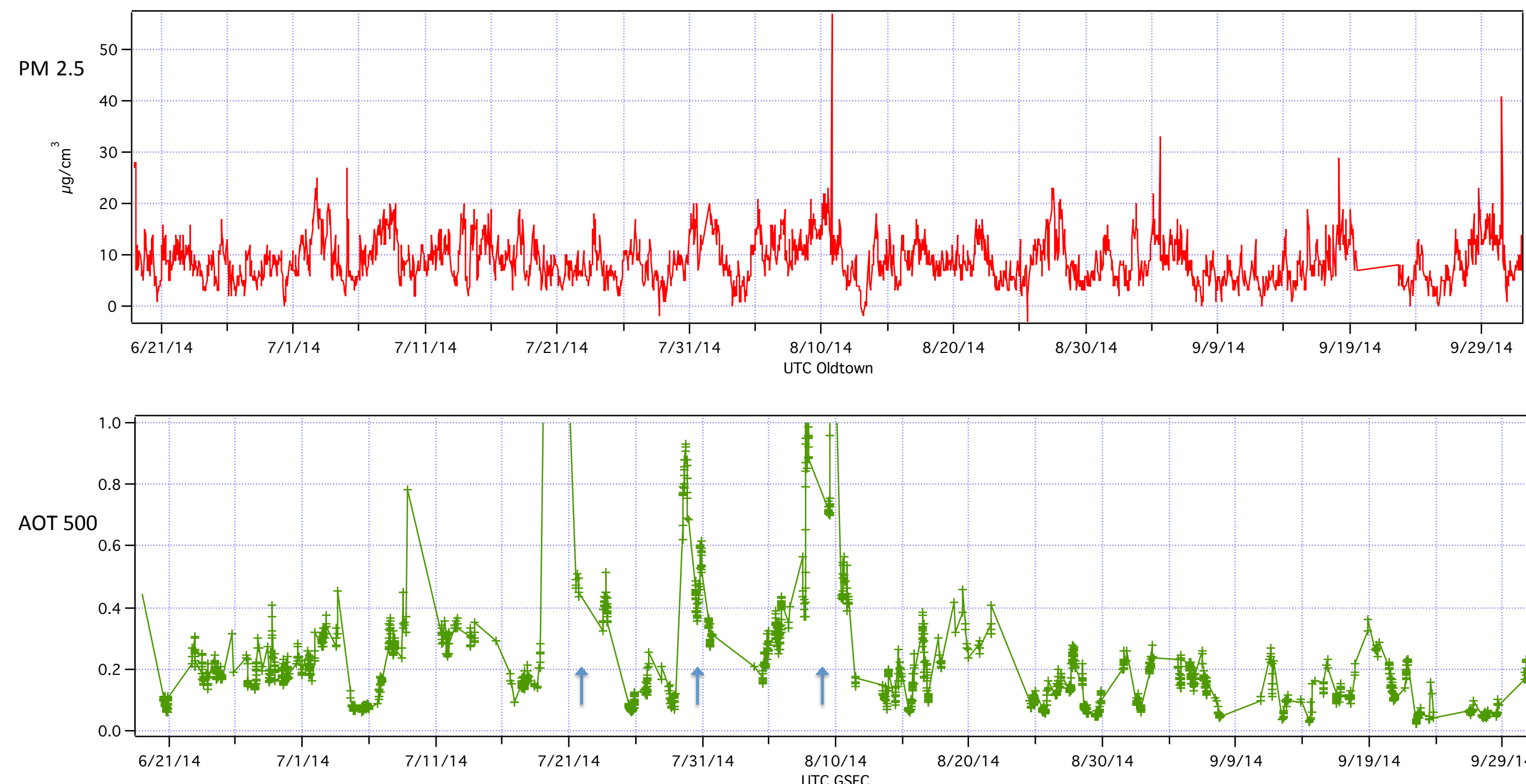
The CALIPSO images below show smoke at 39N 78W between 4 and 6 km altitude. The table on the right records dates where smoke is over MD in pink, yellow records known pyroCbs from Canada, and green are for pyroCbs in the US. Note that on many of the MD smoke days there are Canadian pyroCbs which started 2 to 3 days earlier. Backward HYSPLIT trajectories were taken from the CALIPSO data using that altitude and location. Also a forward trajectory was taken from the pyroCb shown above.



8/2/14	BC 2:45UTC	53N 125W cimss-pyro
8/3/14	OR-CA border	
8/4/14		
8/5/14	NT 20UTC	.2 AOD, Shagerstown remarkable sunset by JHU
8/6/14		
8/7/14		
8/8/14		
8/9/14	south fork OR	OMPS map and calipso
8/10/14		
8/11/14	N California	also pyrocb in Russia
8/12/14	BC 120W 57.5N	
8/13/14		
8/14/14		
8/15/14		OMPS-AOD2.1



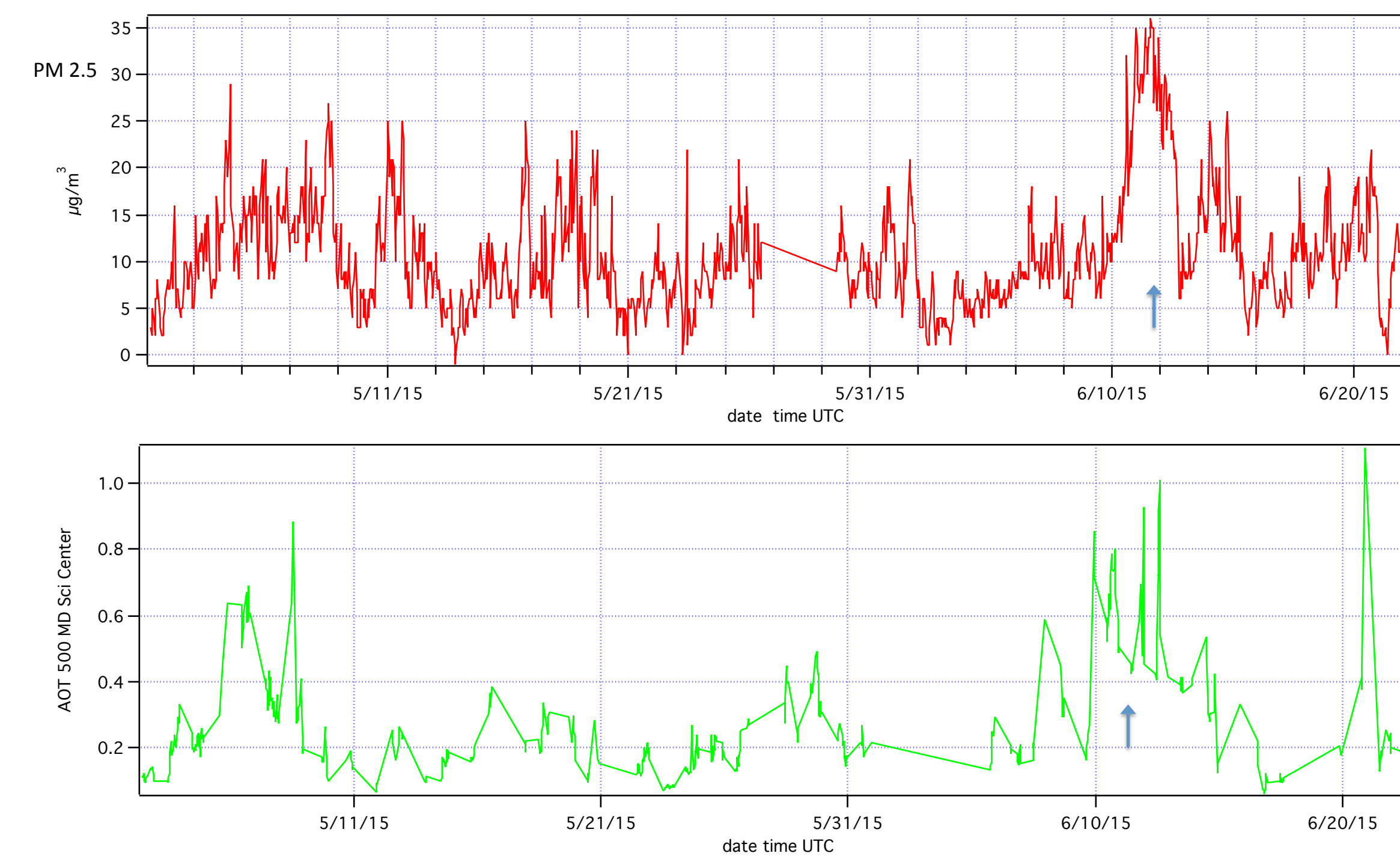
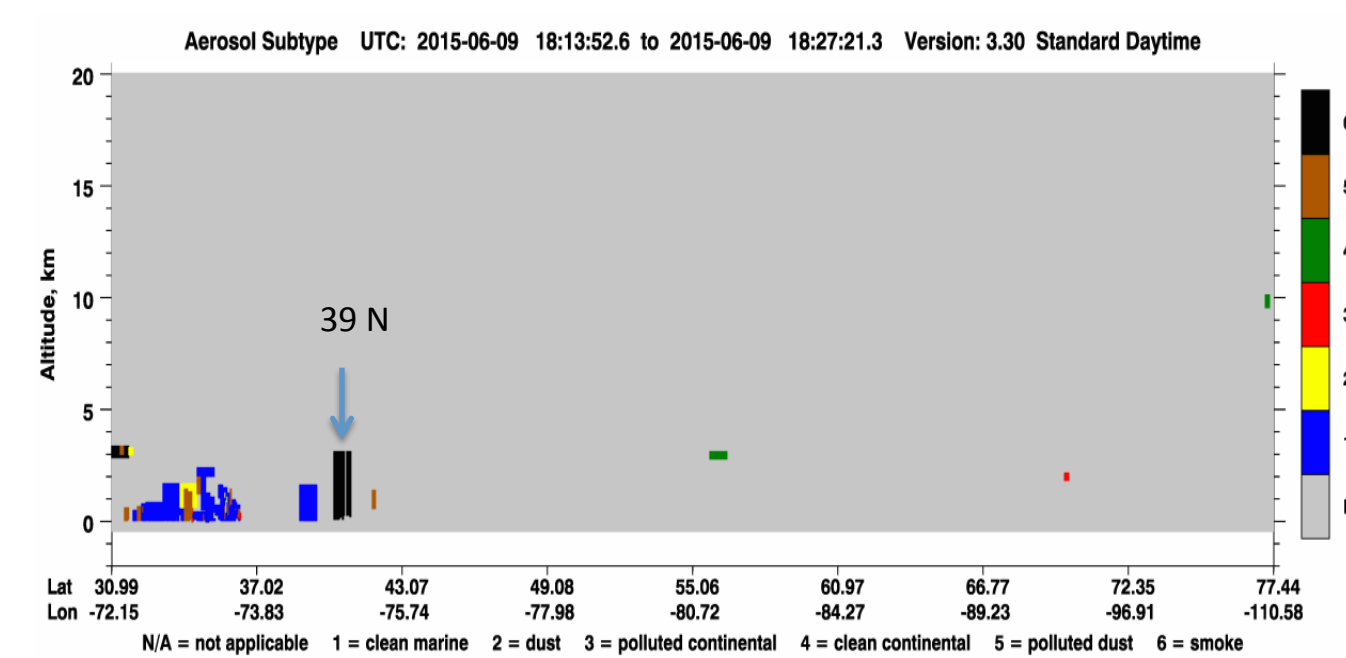
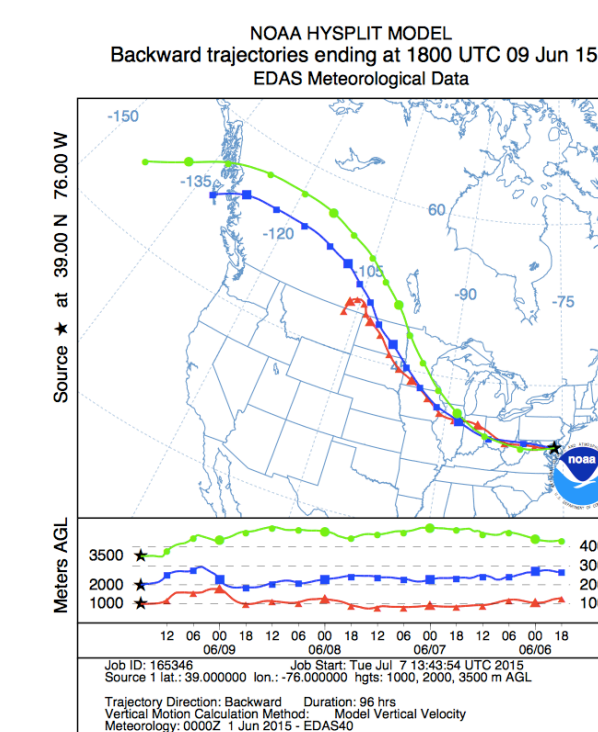
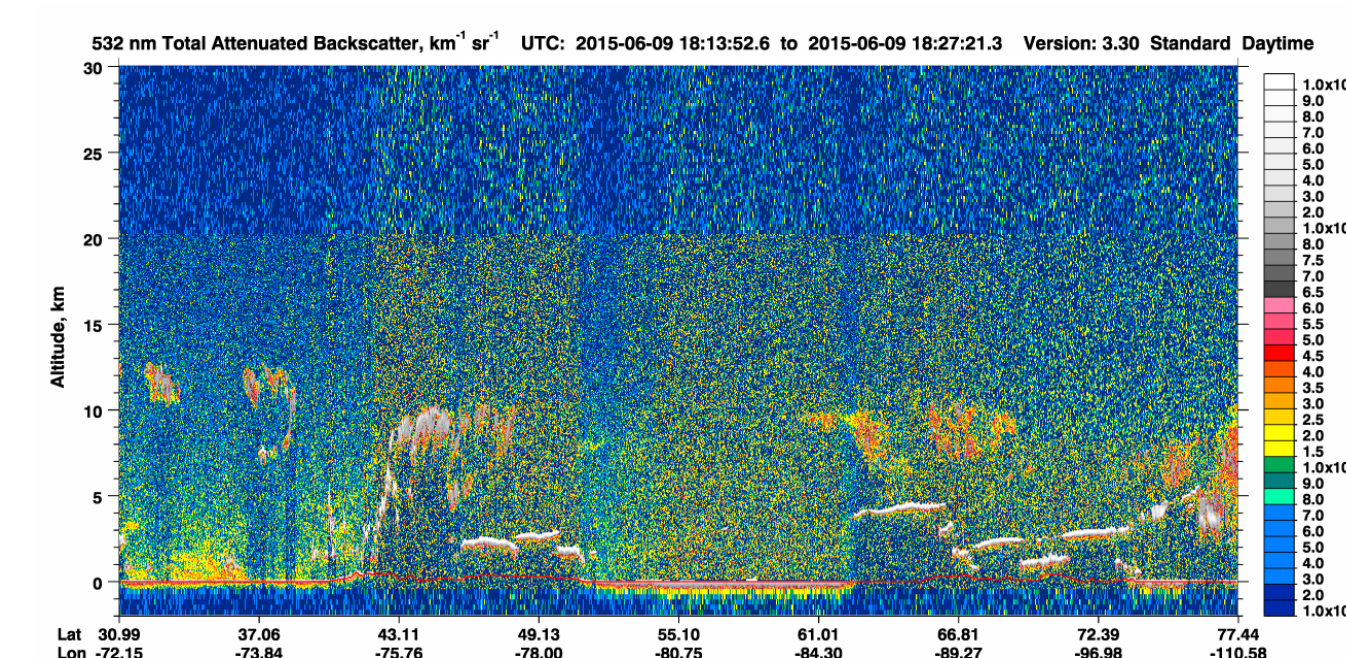
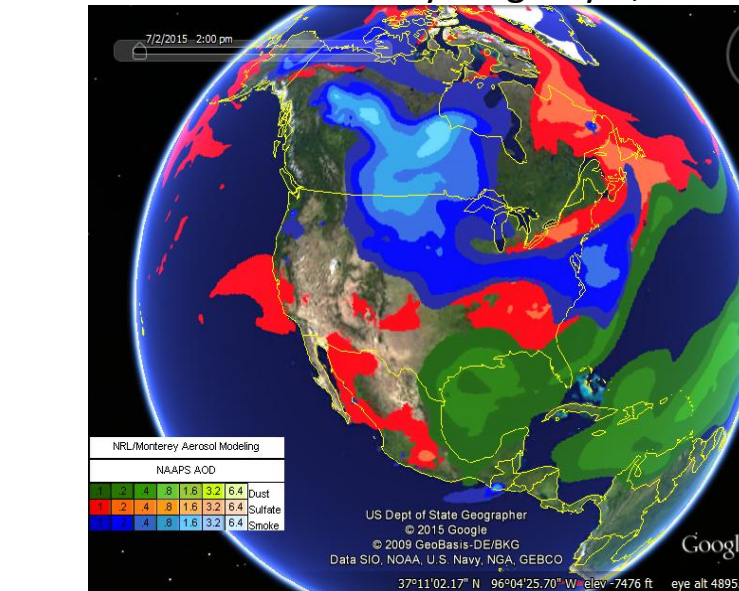
The top graph below is PM 2.5 data from Oldtown in Baltimore City and the bottom is AOT 500 from GSFC. The AOT data shows peaks corresponding to smoke episodes (labeled with blue arrows) and the PM 2.5 does not.



Summer of 2015 preliminary results

At this time it would seem that 2015 may produce another peak year for Canadian wildfires. There have been 4168 fires this year to date which have consumed 1,422,952 ha. This is well above the 10-yr average of 3028 wildfires and 814,235 ha. (Canadian Wildland Fire Information System, 2015). Also the fire season started earlier and has been producing many pyroCbs. Smoke has made its way to Maryland skies several times this year already. On 6/11/15 the smoke trajectory from Canada differed from the results of last summer and actually touched down to ground level in Maryland causing a worsening in air quality to the moderate level. The photo below on the right shows the haze that resulted (MD photo by Colin Seftor from the pyroCb forum). The CALIPSO results for 6/9/15 show smoke from 1 to 3 km in altitude. The HYSPLIT backward trajectory from Maryland on that date and elevation, goes back to a source in western Canada. On 6/11/15 both the ground-sampled PM 2.5 and the column-sampled AOT 500 showed corresponding peaks, since the smoke touched ground that day as reported in the US Air Quality blog.

from US Air Quality blog July 7, 2015



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